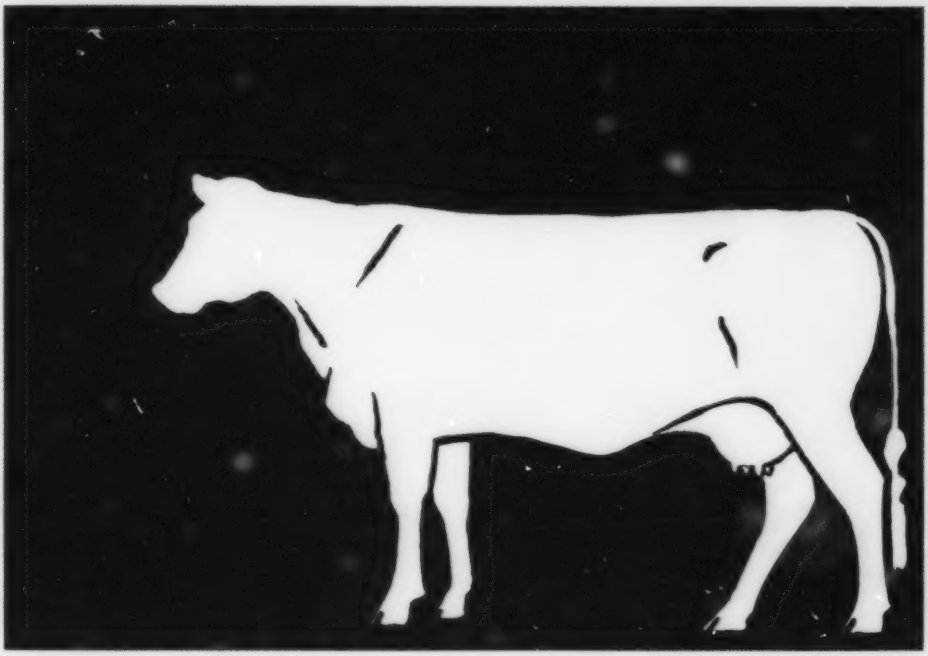
PUBLICATION 357

Cow weight and milk yield in beef production



Ontario
Ministry of Agriculture and Food
UNIVERSITY of GUELPH

Cow Weight and Milk Yield in Beef Production

M. McMorris
Beef Cattle Specialist
Animal Industry Branch
Fergus, Ontario

J. Wilton
Department of Animal and Poultry Science
University of Guelph
Guelph, Ontario

A. McBurney and C. Watson
Elora Beef Cattle Research Centre
University of Guelph
Guelph, Ontario

This research was conducted at the Elora Beef Cattle Research Centre by the University of Guelph under agreement with the Ontario Ministry of Agriculture and Food. Data analysis were performed at the Centre for Genetic Improvement of Livestock, Department of Animal and Poultry Science, University of Guelph. The authors wish to thank the staff at the research centre, C. Haworth and the staff at the meat laboratory, B. Szkotnicki for computing assistance and G. Costigan for manuscript preparation. Additional financial support was provided by the Red Meat Development Plan of the Ontario Ministry of Agriculture and Food.

92-06082/

CONTENTS

Introduction 3
Biological Measurements 8
Estimating Profitability 10
Other Factors Affecting Profitability 11
Economic Comparison of Breeding Systems 11
Cow Weight Effects on Measures of Profitability 12
Milk Yield Effects on Measures of Profitability 13
Profitability at the Farm Level 13
Interpretations and Conclusions 15

Line drawings by E.P. de Rose; photographs by M. McMorris and Ontario Ministry of Agriculture and Food Photographic Services.

INTRODUCTION

What cow weight and level of milk production are most profitable? Increases in both cow weight and milk yield have been shown to be associated with increased output (amount of product being sold). Profitability, however, depends largely on relative levels of output and input (feed and other requirements). In order to determine the effects of cow weight and milk yield on profitability, one must first examine their effects on output and input.

A study was performed to look at the effects of increased cow weight and milk yield on both biological measurements and economic efficiency. Biological measurements are those taken on an animal while economic efficiency involves some measure of profitability. Data were collected on 660 calvings of purebred Hereford, and small and large rotationally crossbred cows at the Elora Beef Cattle Research Centre between 1979 and 1983. The three breeding systems are described in Figure 2. Cows were housed in confinement and fed a silage based diet (typically 50% corn silage, 50% haylage) year round according to requirements for maintenance, milk production and growth (for young cows). Cow weights and milk yields were recorded at six-week intervals after calving.

Calves were fed a creep feed consisting of haylage (75%) and oats (25%). Castrated male calves were placed in the research station feedlot facility shortly after weaning at approximately 6 months of age. Feedlot diets consisted of corn silage and high moisture corn. Animals were marketed and carcass measurements taken when A1 finish (.3 inches or 7 mm of backfat) had been reached.

The use of electronic headgates allowed the feed intake of each cow and feedlot animal to be recorded. Creep feed intake was measured on a pen basis, each pen generally holding six cow-calf pairs. Feed intakes are reported as weight on a dry matter basis. In determining costs, diet composition was considered since feed prices depend on energy and protein content.

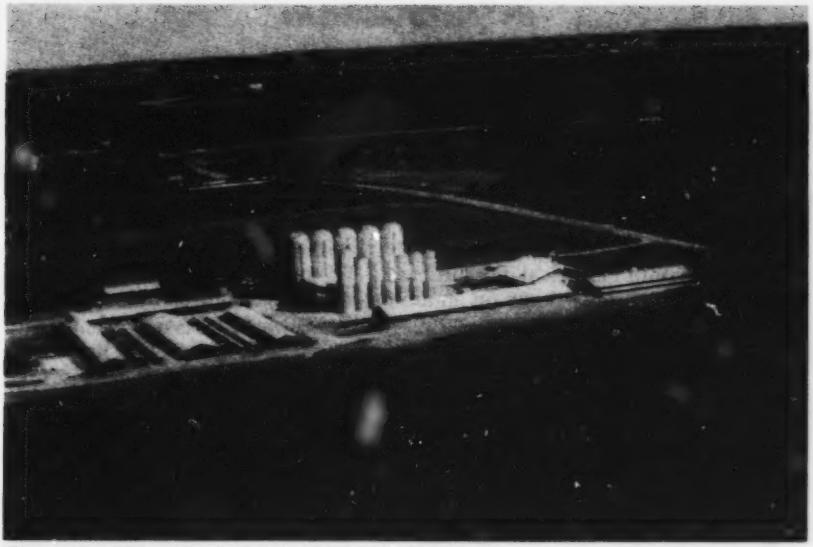
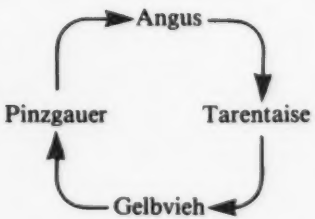


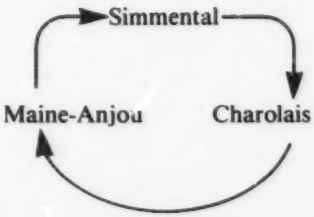
Figure 1. Elora Beef Cattle Research Centre.

1. Hereford

2. Small Cross[a]



3. Large Cross[a]



[a]*Order of breed use varied*

Figure 2. Breeding Systems Being Compared

Figure 3. Hereford in this study averaged 1320 pounds and 8.5 pounds of milk per day.

Figure 4. Pinzgauer sired cow with Gelbvieh sired calf representing animals moderate in weight with high milk yield.

Figure 5. Charolais sired cow with Simmental sired calf representing heavy animals with high milk yield.

Figure 6. Several measurements of milk yield were used with cow weight to provide a specific description of each animal.

Figure 7. Electronic headgates formed part of a unique feeding system which provided measurement of individual feed intake.

Figure 8. Animals were marketed at A1 finish to match commercial practice.

BIOLOGICAL MEASUREMENTS

Milk yield, cow and calf weights, and feed requirements of each breeding system are shown in Table 1. Cows milking at higher levels (i.e. small cross and large cross) lost more weight and condition during lactation than did Hereford cows. Calves of small and large cross cows were heavier at weaning, required more time in the feedlot and finished at higher weights. As output (weaning or market weight) increased, however, so did feed requirements.

Table 1. Breeding system values for cow-calf and feedlot traits

		Hereford	Small Cross	Large Cross
Cow traits	Cow weight - calving	1320	1360	1580
	(lb) - weaning	1310	1300	1550
	Cow backfat - calving	.47	.41	.33
	(in) - weaning	.46	.32	.27
	Milk yield (lb/day)	8.5	14.0	16.0
Calf traits	Weaning weight (lb)	450	540	600
	Days on feed (days)	127	197	226
	Market weight (lb)	850	1120	1260
Feed requirements (lb DM)	Cow during lactation*	3610	4140	4930
	Cow while dry*	2675	2860	3240
	Creep feed**	680	620	590
	Feedlot***	2470	3930	4690

**Based on a diet consisting of corn silage and haylage*
***Based on a diet consisting of haylage and oats*
****Based on a diet consisting of corn silage and high moisture corn*

The effects of a 100 lb increase in cow weight at a given level of milk production appear in Table 2. Gestation length increased approximately one half day per 100 lb of cow weight. Heavier cows produced calves which were heavier at birth, weaning and market finish. Increased cow weight had little effect on average daily gain of calves in the feedlot. This was an unexpected result since large breeds (eg. Charolais) generally have higher rates of gain than do smaller breeds (eg. Hereford). Calves of large cows reached a high market weight through an increased number of days on feed.

Table 2. Cow size and milk yield effects on productivity and feed requirements[a]

		Increases per 100 lb increase in cow weight	Increases per 5 lb/day increase in milk yield
Calf traits to weaning	Gestation length (day)	.4*	.3
	Birth weight (lb)	4.3*	3.4*
	Weaning weight (lb)	14*	61*[b]
Feedlot traits	Average daily gain (lb/day)	.02	.04
	Days on feed (days)	11*	7
	Market weight (lb)	50*	50*
Feed requirements (lb DM)	Cow during lactation	225*	339*[b]
	Cow while dry	95*	232*[b]
	Creep feed	−3	−53*[b]
	Feedlot	285*	93

[a]*Based on 317 cows and 660 observations from 1979-1983*
[b]*Effect diminishes as milk yield increases*
**Statistically significant (P<.05)*

As expected, large cows required more feed for maintenance. Creep feed intake was not affected by cow weight. Calves of large cows required more feed in the feedlot to reach A1 finish at a higher weight.

The effects of a 5 lb per day increase in milk yield at a given cow weight are also presented in Table 2. This change in milk yield may be put in perspective by noting that the large cross cows produced 7.5 lb more milk per day than did Hereford cows. Increased milk yield was associated with a slight increase in gestation length. Birth, weaning and market weights as well as rate of gain and days on feed were all increased. Feed requirements of cows with increased milk yield were higher, particularly during lactation. Increased milk yield caused creep feed intake to decrease. Calves from cows milking at high levels required more feed while in the feedlot to reach a heavier market weight. The effects on weaning weight, creep feed and cow feed diminished at higher levels of milk yield (Table 3).

Table 3. Changes in relevant traits due to 5 lb/day increases in milk yield

Trait	Increase in Milk Yield (lb/day)		
	from 5 to 10	from 10 to 15	from 15 to 20
Weaning weight (lb)	50	39	27
Cow feed - lactation (lb DM)	257	221	161
- dry period (lb DM)	189	144	100
Reduction in creep feed (lb DM)	40	26	12

ESTIMATING PROFITABILITY

The above results indicated, as expected, that increased cow weight and milk yield caused increases in both output and input. The level of increase in output and input can be used to study the effects of cow weight and milk yield on profitability. Cost of production and, to a lesser extent, price of market animals differ from one farm to another. General statements concerning profitability, therefore, may not apply to many producers. For this reason, returns less feed costs were used as a simplified measure of profitability. Returns less feed costs are calculated as the income received from the sale of an animal less the cost of feed needed to produce that animal. These values should give a good indication of profit since feed represents a major cost of production. Returns less feed costs values are higher than profit since not all costs are accounted for.

Returns less feed costs were calculated using information on each calf, for cow-calf, feedlot and integrated enterprises. Output and inputs to specific endpoints were used in calculating the various returns less feed costs. The cow-calf enterprise involved the sale of weaned calves while the feedlot enterprise involved the feeding of weaned calves through to market finish. The integrated enterprise involved a cow herd with calves being fed to market finish. Salvage value of the cow as well as feed required for a replacement heifer were considered when calculating returns less feed costs for the cow-calf and integrated enterprises.

The potential economic benefits of specific breeding systems and increased cow weight and milk yield will depend on the cost of feed. The value of increased output may be greater than the cost of increased input at a low feed cost but not at a high feed cost. The relationship between the price of beef and the cost of feed is obviously important. This relationship, called the beef to feed ratio, was calculated for 14 years using yearly average beef and feed prices for Ontario. The average and highest (indicating cheap feed) ratio values were used in this study to investigate the effect of feed cost on profitability as cow weight and milk yield change. The price of beef was held constant at the 1983 average while corresponding average and low feed costs were considered. Beef prices and average feed costs used in this study are outlined in Table 4.

Table 4. Beef prices and average feed costs used in calculation of returns less feed costs

Beef or feed	Value
A1 market cattle (1983 average)	$0.79 per lb
Weaned calves	$0.81 per lb
Cull cows	$0.52 per lb
Cow feed (50% corn silage, 50% haylage)	$67.97 per ton (DM)
Creep feed (75% haylage, 25% oats)	$68.36 per ton (DM)
Feedlot feed (50% corn silage, 50% high moisture corn)	$95.66 per ton (DM)

OTHER FACTORS AFFECTING PROFITABILITY

Another measure of profitability, "Plus", considered returns, feed costs, feedlot overhead expense, price premiums for higher retail yield and discounts for underweight and overweight carcasses. This more comprehensive measure of profitability was used to examine cow weight and milk yield effects when factors other than returns and feed costs are considered. Only price premiums for retail yield were included in the calculation of "Plus" for the cow-calf enterprise. Using average Ontario figures, feedlot overhead expense was calculated to be 32 cents/head/day. Feedlot overhead expense was charged according to the number of days required to reach A1 finish.

The majority of animals in this study were discounted for either light or heavy carcasses (Table 5). Liveweight market prices were discounted 1¢/lb for those animals producing a carcass of less than 550 lb; 2¢/lb for carcasses less than 475 lb; 2¢/lb for carcasses greater than 725 lb; and 3¢/lb for carcasses greater than 800 lb. No discounts applied to those animals which produced carcasses between 550 and 725 lb. Premiums of 2¢/lb liveweight were paid for each 1% increase in retail yield percent as estimated using rib eye area and fat cover. A similiar premium was paid for weaned calves to reflect their increased value to the feedlot operator. These discounts and premiums are more precise than those currently in practice but do reflect current market trends.

Table 5. Number of animals in each carcass weight category by breeding system

Breeding System	Carcass Weight (lb)					
	<475	475-550	551-725	726-800	>800	Total # of Animals
Discount (¢/lb Liveweight)	2	1	0	2	3	
Hereford	20	28	6	1	0	55
Small Cross	12	8	21	7	9	57
Large Cross	1	2	33	14	32	82

ECONOMIC COMPARISON OF BREEDING SYSTEMS

Returns less feed costs ($/cow) for each breeding system are presented in Table 6. As expected, returns less feed costs were higher with lower feed costs. Regardless of enterprise or feed cost, large cross cows yielded higher returns less feed costs than did small cross cows which in turn were higher than Hereford. The advantage of large cross cows over Hereford cows, for cow-calf returns less feed costs, was lower with average feed cost ($33) than with low feed cost ($54). This indicates that as feed costs are reduced, the economic advantage of larger cattle increases.

Table 6. Returns less feed costs ($/cow) by breeding system

Type of Enterprise	Feed Costs	Breeding system[a]		
		Hereford	Small Cross	Large Cross
Cow-Calf	Average	143	166	176
	Low	219	248	273
Feedlot	Average	157	246	284
	Low	188	293	345
Integrated	Average	284	312	348
	Low	346	440	507

[a]*Results relate specifically to the breeding systems described in Figure 1. Use of different breeds may alter results.*

COW WEIGHT EFFECTS ON MEASURES OF PROFITABILITY

The effects of a 100 lb increase in cow weight, at a given level of milk yield, on returns less feed costs are shown in Table 7. The effect of cow weight was enhanced with low feed costs as found when comparing breeding systems. Feedlot returns less feed costs were more positively affected by increased cow weight than were those for cow-calf production. Since animals were sold at A1 finish rather than at weaning, the effects of cow weight were more fully expressed. Increased cow weight had an even greater benefit for integrated returns less feed costs.

Table 7. Change in returns less feed costs ($/cow) with increases in cow weight and milk yield

Type of Enterprise	Feed Cost	Change per 100 lb increase in cow weight	Change per 5 lb/ day increase in milk yield
Cow-Calf:	Average	7*	15*[a]
	Low	10*	21*[a]
Cow-Calf Plus[b]:	Average	13*	19
Feedlot:	Average	15*	13*
	Low	19*	14*
Feedlot Plus:	Average	15*	11*
Integrated:	Average	16*	42*
	Low	24*	50*
Integrated Plus:	Average	21*	39

**Statistically significant $P<.05$* [a]*Effect diminishes as milk yield increases*
[b]*Plus refers to the consideration of feedlot overhead expense, price premiums for retail yield and discounts for underweight and overweight carcasses. Only retail yield related premiums were considered for the cow-calf enterprise.*

The consideration of other factors (Plus) indicated a greater benefit of increased cow weight for the cow-calf production system while the effect on feedlot returns less feed costs did not change. Increased cow-calf returns less feed costs were due to price premiums for larger calves which were expected to have higher retail yield at market weight. The consideration of other factors had an intermediate influence on integrated returns less feed costs. In general, the consideration of factors other than feed cost had little influence on cow weight effects.

MILK YIELD EFFECTS ON MEASURES OF PROFITABILITY

The effects of a 5 lb/day increase in milk yield, at a given cow weight, on returns less feed costs are presented in Table 7. The effect of milk yield on cow-calf returns less feed costs changed depending on feed cost. With a lower feed cost, increased milk yield resulted in higher returns less feed costs. There appeared to be an optimum level of milk yield beyond which returns less feed costs decreased. This optimum was very high, being approximately twice the yield of large cross cows. The optimum level of milk yield was higher with lower feed cost. The consideration of other factors (Plus) caused the effect of milk yield on cow-calf returns less feed costs to increase while the effects of milk yield on feedlot and integrated returns less feed costs decreased.

Increased milk yield resulted in higher feedlot returns less feed costs. Previous studies have shown little or no effect of milk yield on feedlot returns less feed costs. The increase found in this study resulted from the fact that milk yield increased market weight (source of income) more than it did weaning weight (expense). Carcass weight, however, was only increased to the same extent as weaning weight. Returns less feed costs were calculated using live animal market weights. Had returns less feed costs values been calculated using carcass weights, the effect of milk yield on feedlot returns less feed costs would have been greatly reduced.

Increased milk yield caused integrated returns less feed costs to rise quite dramatically. Integrated returns less feed costs were affected by increased returns less feed costs both to weaning and during the feedlot phase of production. As with the other types of enterprise, increased milk yield became more beneficial with lower feed costs.

PROFITABILITY AT THE FARM LEVEL

Total profit will depend on profit per cow and the number of cows in the herd. Carrying capacity (number of cows kept as determined by labour, space or feed supply) is, therefore, an important consideration. Using the feed requirements of the breeding systems studied, one may develop an example in which feed supply acts as a limit to herd size. The following example is based on a 100 acre farm, completely workable, on which is grown 50 acres of corn silage and 50 acres of hay. Using average yields and energy content of feedstuffs, a total supply of feed energy was calculated. Feed energy, rather than feed weight, was used to account for differing energy content of feedstuffs.

Numbers of cow-calf pairs or feedlot animals were calculated as total feed energy divided by feed requirements for each breeding system (Table 8). These numbers, multiplied by the returns less feed costs values calculated earlier on a per animal basis, gave farm level returns less feed costs values (Table 8). Breeding systems were very similar when compared using returns less feed costs calculated at the farm level. Caution is advised when interpreting the farm level feedlot comparison of breeding systems. Feedlot animals were fed a relatively high energy ration shortly after weaning causing Hereford animals to finish quickly at low market weights. Earlier maturing animals such as Hereford may benefit from a lower energy ration in order that market weights be within an acceptable range. The number of Hereford animals that may be supported in the feedlot (Table 8) may be an overestimate. The calculations also assumed no limit on availability of feeder cattle or housing.

Table 8. Farm level returns less feed costs for three breeding systems and three types of enterprise (low feed cost)

Type of Enterprise		Breeding systems		
		Hereford	Small Cross	Large Cross
Cow-calf	# of cows	83	76	66
	RLFC [a] ($/cow)	219	248	273
	RLFC ($/farm)	18,177	18,848	18,018
Feedlot[b]	# of animals	207	130	109
	RLFC ($/animal)	188	293	345
	RLFC ($/farm)	38,916	38,090	37,605
Integrated[b]	# of cows	59	48	41
	RLFC ($/cow)	346	440	507
	RLFC ($/farm)	20,414	21,120	20,787

[a] *RLFC = returns less feed costs*

[b] *Values relate to a system where weaned calves are put directly in the feedlot*

The effects of cow weight and milk yield on farm level returns less feed costs were studied by projecting the returns less feed costs calculated for each animal to a farm level. Total available feed supply was divided by feed requirements for cow and calf to weaning to give the number of similar animals (weight, milk yield and feed requirements) able to be supported. This number represented herd size for a cow-calf enterprise. Similar calculations using feed requirements for feedlot animal, and cow and calf to market finish gave herd size for feedlot and integrated enterprises. Herd size multiplied by individual returns less feed costs provided farm level returns less feed costs for each animal.

Cow weight and milk yield effects on farm level returns less feed costs appear in Table 9. Both cow weight and milk yield had a small positive influence on cow-calf returns less feed costs. Returns less feed costs for the feedlot enterprise was negatively affected by increased cow weight and milk yield, while that for

the integrated enterprise was negatively affected by increased cow weight but positively affected by increased milk yield. The consideration of other factors (Plus) caused all cow weight and milk yield effects on farm level returns less feed costs to become more positive.

Table 9. Cow weight and milk yield effects on farm level measures of profitability (low feed cost) for three types of enterprise

Type of Enterprise	Effect ($/farm) of a 100 lb increase in cow weight	Effect ($/farm) of a 5 lb/ day increase in milk yield
Cow-calf:	118	40
Plus	445*	183
Feedlot:	−1627*	−987
Plus	−214	−111
Integrated:	−15	64
Plus	546*	526

**Statistically significant* $P<.05$

INTEPRETATIONS AND CONCLUSIONS

Several factors must be noted when interpreting these results. The management program used in this study involved putting calves into the feedlot shortly after weaning. Other programs, such as backgrounding, could have increased market weights and feed requirements. Reproductive performance was not considered since comparisons were made on a cow-calf pair basis. Differences in price for light or heavy market weight animals were considered.

These results relate directly to commercial producers with purebred or rotational crossbreeding programs. The effects of cow weight and milk yield on returns less feed costs would be different for terminal crossbreeding. Other studies involving terminal crossbreeding have indicated that economic benefit is derived by using as large a bull as possible on as small a cow as possible without causing excess calving difficulty. Additional data now being collected will be used to study whether or not cow weight and milk yield effects differ from one breed to another.

The results of this study do answer some basic questions concerning cow weight and milk yield in beef cattle:

On an animal basis (herd size limited by space or labour)

1. Increased milk yield results in sufficient weaned calf to pay for the extra feed required.
2. Increased cow weight results in larger animals in the feedlot that more than pay for their extra feed requirements. There is an advantage of increased cow weight especially for feedlot and integrated enterprises.

On a farm basis (herd size limited by feed supply)

3. Cow weight and milk yield effects on farm level measures of profitability are very small.

Producers must decide which of these relate most directly to their own situation. In cases where economic values differ from those used in this study, producers can use the biological measurements described earlier and the profitability approach to choose the most appropriate cow weight and milk yield.